SILVICULTURE

Correlated Guidelines for Management of Uneven-aged Drybelt Douglas-fir Stands in British Columbia

First Approximation

Province of British Columbia

Ministry of Forests

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Silviculture Interpretations Working Group

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FOREWORD

There is nothing new under the sun.

Selection harvesting of forests has been around since the time of Adam and Eve. Laws, ordinances and regulations for managing silvicultural systems have been around since biblical times in the Middle East and in China since the 12th Century B.C.

The unregulated selection system is the oldest, easiest and crudest form of management; the regulated selection system, with its individualization, is the most delicate and the most difficult form of forest management (Mayr 1907).

Throughout history a sad tale has been repeated of good selection management later ruined by unregulated cutting, animal grazing and utilization.

These guidelines are to be used to promote suitable stocking for future sustained timber production. Other considerations such as wildlife or other resource values must be assessed for each area but are not specifically addressed within these guidelines. This is not because they are of lesser importance, but because they are too complex for this first approximation.

Effective May 1, 1992, these guidelines should be followed for activities on drybelt Douglas-fir stands proposed for uneven-aged management.

The guidelines are, as noted, a "first approximation." Comments from field testing are welcome and will be used in formulating a second approximation.

John Cuthbert
Chief Forester
British Columbia Forest Service

ACKNOWLEDGEMENTS

Yes....there is nothing new under the sun. These guidelines and standards were developed through consultation and review of many existing procedures already used by Districts and Regions. These guidelines are an amalgamation and correlation of existing procedures.

Special thanks to the following for their extensive time and advice:

Cariboo Regional Staff
Alexis Creek District Staff
100 Mile House District Staff
Williams Lake District Staff
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Kamloops District Staff
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Cranbrook District Staff
Invermere District Staff
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Timber Harvesting Branch
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Peter Semenoff

Our appreciation is also extended to Bryce Bancroft of Madrone Consultants Ltd. and T.D. Mock and Associates Inc. for their assistance in compiling and producing this publication.

The Silviculture Interpretations Working Group would like to acknowledge Ralph Winter for his commitment and dedication to the production of this set of guidelines.

Silviculture Interpretations Working Group

SILVICULTURE INTERPRETATIONS WORKING GROUP

The Silviculture Interpretations Working Group has been established as part of the provincial ecological correlation project. The group includes the following representatives from the Ministry of Forests and forest industry associations.

Robin Brown	Silviculture Branch
Gordon Burton	COFI
Don Couch	ILMA
Ken Dowding	Vancouver Forest Region
Neil Endacott	Prince Rupert Forest Region
Tim Harding	CLMA
Gary McKellar	COFI
Ron Newman	Kamloops Forest Region
Bruce Pamplin	Prince George Forest Region
Bernie Peschke	Nelson Forest Region
Barry Penny	Cariboo Forest Region
Laird Pittman	ILMA
Kelly Powell	CLMA
Dave Presslee	COFI-NILS
Dave Schwarz	CLMA
George White	CLMA
Ralph Winter	Silviculture Branch
Mike Wyeth	Silviculture Branch

The Group is responsible for correlating silviculture interpretations for the biogeoclimatic classification system.

Correlation of stocking standards and procedures for selection logging areas is the Silviculture Interpretations Working Group's second project. The Group has undertaken this task on behalf of the Director, Silviculture Branch to ensure consistency between regional stocking standards in accordance with Basic Silviculture Stocking Standards Policy III-Sil-009.

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INTRODUCTION

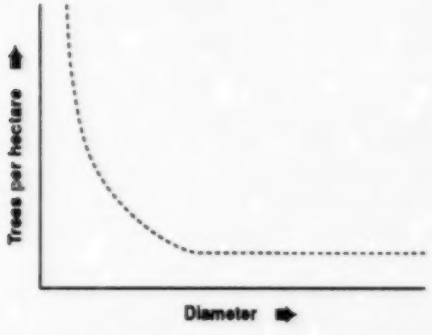
These guidelines are a correlation of many guidelines for uneven-aged stand management already in place in many Forest Districts and Regions in British Columbia. These correlated guidelines are intended to promote those procedures and activities that will ensure sustainable uneven-aged stands on appropriate interior drybelt Douglas-fir ecosystems within the Interior Douglas-fir zone.

Definition

Uneven-aged drybelt Douglas-fir management has been practised for over 50 years in British Columbia. **Uneven-aged silviculture and management** is the manipulation of a forest for a continuous high forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of age or diameter classes to provide a sustained yield of forest products.

Selection Systems

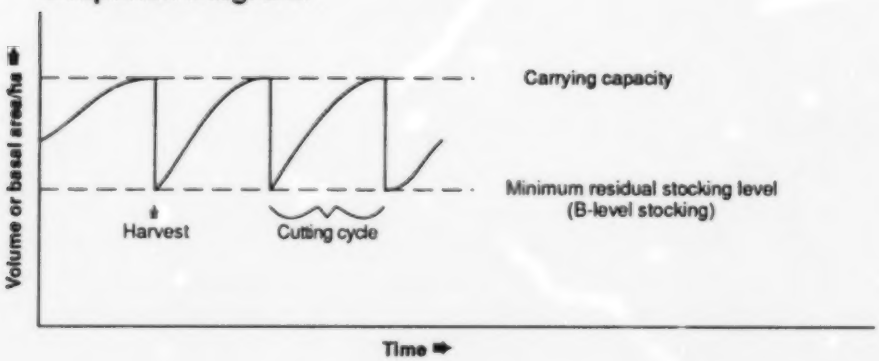
Managed uneven-aged forests are characterized by trees of many ages and sizes intermingled singly or in groups. Silvicultural systems used to create or maintain uneven-aged stands are called **selection systems**. Trees are harvested singly or in very small groups and the process of regeneration of the desirable species occurs either continuously or following each harvest. The selection system may include thinning and cultural treatments to promote growth and maintain or enhance stand structure.



A basic concept of selection is that each stand has a maximum carrying capacity for volume or basal area. This basal area is spread over a range of tree sizes, typically ranging from small trees to a few large trees.

At each harvest entry, a proportion of the carrying capacity is removed. Once this volume or basal area has regrown, the area can be harvested again. The period between harvests (the cutting cycle) depends on the amount of volume or basal area removed, the growth rate of the residual stand, and how long it takes to return to carrying capacity. The manager can manipulate these variables (cutting cycle, basal area removed) to meet various objectives.

Simplified Diagram:



This system has often also been termed diameter limit cut, partial logging, selective logging or faller selection. These stands, before or after harvesting, may consist of a combination of veterans, sawlogs, poles, saplings and seedlings. This method of harvesting occurs on about 15 000 hectares of drybelt Douglas-fir stands annually.

In order to manage sites planned for a selection system, the stand structure must be properly described, planned, harvested, and monitored. These complex stands must be described and evaluated at the following stages of development: pre-harvest cruise, pre-harvest silviculture prescription (PHSP), during harvest, post-harvest assessments, regeneration delay, and free growing.

Two of the clear requirements for proper management of uneven-aged drybelt Douglas-fir stands are clearly defined goals and measurable objectives.

These provincially correlated guidelines are intended to provide standards and guidance that may not be included in current Ministry manuals or procedures. These guidelines include the standards and methods of evaluation recommended to properly administer and monitor selection systems in drybelt Douglas-fir stands.

STATEMENT OF PRINCIPLES, STANDARDS AND PROCEDURES

Selection systems require detailed planning, monitoring and regulation to ensure that long-term regeneration capabilities and harvesting options are maintained.

The intent of these procedures is to ensure that:

- All areas proposed for selection logging have defined goals and measurable objectives.
- Regulated stand management is used to maintain, promote and/or establish multi-diameter or uneven-aged stand structure.
- Regeneration or regeneration capability is maintained or enhanced.
- The long-term productivity and adaptability of populations managed under selection systems are not reduced through loss of genetic variability or increased levels of inbreeding.
- Stands regenerated using selection systems will be sufficiently genetically diverse to be considered on-site gene reserves.
- These stands will be primarily regenerated naturally.
- Prior to harvest, each stand will have a stand structure goal and planned cutting cycles will be identified.
- Prior to harvest, each stand will have a planned residual basal area/hectare.
- Tree layers will be used for measurement of stocking on a site. The 4 layers from top to bottom are:

  layer 1 trees equal to or greater than 12.5 cm dbh
  layer 2 trees 7.5 cm to 12.4 cm dbh
  layer 3 trees 1.3 metres height to 7.4 cm dbh
  layer 4 trees less than 1.3 metres in height.
- Each layer within the stand will have specific stocking standards and evaluation criteria.
- Each layer may contribute to the stocking status of the stand as a whole.
- Specific basic silviculture obligations may be attached to an individual stand layer or combination of layers.
- Administration and regulation of harvesting of these stands will be consistent throughout British Columbia.

Goals for Uneven-aged Management

Goals for uneven-aged management may include:

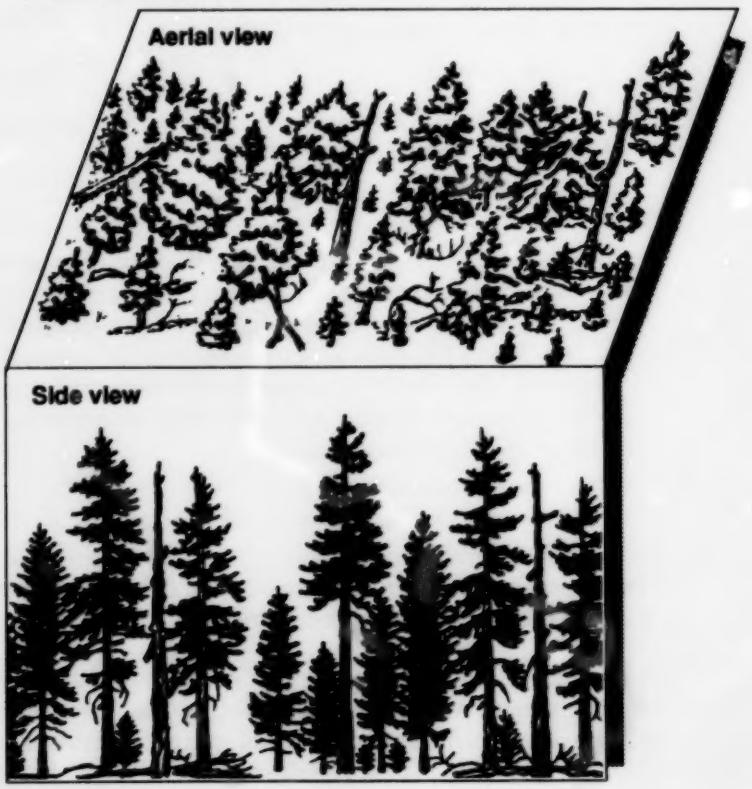
- Timber production.
- Maintenance of wildlife winter range (e.g., of mule deer).
- Water management.
- Maintenance of the visual quality of the landscape.
- Enhancement of recreation objectives, such as maintenance of high forest cover around important lakes.
- Moderation of microclimate extremes to ensure continued forest reproduction.
- Maintenance of biological and genetic diversity of natural populations.

The enclosed guidelines are for timber production and may need to be adjusted on a site-specific basis during the preparation of a Pre-Harvest Silviculture Prescription (PHSP) to accommodate other resource management objectives such as those outlined above.

APPLICABLE STANDS

These procedures have been prepared for interior drybelt Douglas-fir stands where uneven-aged management is prescribed. The procedures were not designed for the management of other conifer species. Uneven-aged management in other ecosystems may require different approaches not covered by these guidelines.

Candidate stands for uneven-aged management should be identified at the development plan stage and detailed at the PHSP and Cutting Permit stage. Prospective stands usually consist of trees with a range in height and diameter distributions. However, some stands may not have a range of diameter classes or uneven-aged distributions prior to harvest. Multiple harvest entries may be necessary in order to create a desired stand structure.



STRATIFICATION

Stratification is the process of identifying relatively uniform units within a proposed cutblock. The objective of stratification is to improve sampling efficiency, decrease variation in survey information and improve management decisions by delineating homogeneous forest cover types. It must balance the need for identification of areas with the need for practical treatment units.

Historically, stratification in selection areas has been a serious problem. Photography, preferably at a scale of 1:10 000 to 1:15 000 should be available before a survey is undertaken in these stand types.

The following criteria should be considered in stratifying selection areas before and after harvest:

- Management goals.
- Planned silviculture treatments.
- Forest cover timber type.
- Differences in treatment history.
- Site sensitivity.
- Ecosystem classification.
- Riparian resource management objectives.

When stratifying into treatment units, the minimum size should also be feasible for management, stumpage appraisal purposes and record-keeping. Considerations used for stratification in previous assessments should be incorporated into any revised stratification of an opening. Type sizes should be large enough to be photo-interpreted, identified on the ground and represented on maps.

Excessively small types or polygons will be difficult to maintain and keep current. Thus small inclusions of other than the main forest type may be included within the identified cutblocks.

Where possible, the pre-harvest cruise will identify only one major treatment unit within a proposed cutblock. To avoid making management and administration of uneven-aged stands more complex than they already are, it is recommended that proposed cutblocks be

developed within one distinct forest cover type per stratum and that only one stand structure goal, one set of stocking standards, and one silviculture regime be developed for a cutblock.

This may require smaller areas (of similar stand structure) to be identified as unique cutblocks and obligations. This may require more planning and administration initially, but will be mitigated through time savings in later administration of stand structure goals and management of Cutting Permit and PHSP standards.

PRE-HARVEST CRUISE

The following list of points, each discussed in this section, should be considered during the pre-harvest cruise:

- Timber typing/stratification.
- Plot sizes.
- Data collection requirements.
- Summarizing data.
- Setting stand structure goals.
- Handling stand structure deficits/surpluses.
- Ensuring sufficient leave trees.

To properly plan uneven-aged management, a pre-harvest cruise must be carried out. The pre-harvest cruise provides specific stand information required to properly complete the PHSP and the Cutting Permit document (see Appendix 6 for data collection scheduling).

Cruise data must be collected on the entire stand to:

- Understand the structure of the stand proposed for harvesting.
- Provide information necessary for the development of the standards and conditions in the PHSP and Cutting Permit.
- Plan the post-harvest stand structure.
- Administer the cutting permit and regulate harvesting.

Cruising should follow normal procedures for uneven-aged drybelt Douglas-fir stands with the addition of information on the trees in each of the layers below 12.5 cm diameter at breast height (dbh).

Proper timber typing/stratification must be carried out prior to and during the cruise. Broad typing and lumping of different forest cover types/stand structures "washes-out" the data and makes it useless for projecting stand management and regulating selection harvesting.

To collect data required for uneven-aged management, two plot sizes are used.

Layer 1 (Trees 12.5 cm dbh and larger)

Standard cruise procedures should be used with fixed area or prism plots. The fixed area or prism plot size chosen for a stratum should yield an average of 8 to 10 crop trees per plot. The recommended fixed area plot size is 0.04 hectares (11.28 m radius). The plot size chosen may be adjusted from the standard 0.04 hectare plot size according to the stand characteristics. If a 0.04 hectare plot size is chosen, the same-sized plot must be used for the entire stratum.

Crop trees shall be defined as those merchantable stems to be appraised and harvested to specified utilization standards. In the majority of cases, the minimum utilization standards are 12.5 cm dbh for lodgepole pine and 17.5 cm dbh for other species. Trees below the minimum diameter limits may be specified for harvesting with Special Forest Product rates applied.

The cruise design must be a systematic and alternating grid design with a plot intensity that will meet one of the following sampling error objectives:

- ± 15% at 2 standard errors based on a compilation to the appraised minimum dbh based on cut stems.
- ± 10% at 2 standard errors based on a compilation to the appraised minimum dbh based on all stems (cut and leave stems).
- Sampling error is waived with a sampling intensity of one plot per ha (100 m x 100 m grid spacing) where the coefficient of variation of the stand structure may be too high and the achievement of the above sampling errors may not be practical.

The regular cruise cards may be used to collect data on trees equal to or greater than 12.5 cm dbh. Utilization standards in the cutting authority will specify diameter size specifications.

Reference: B.C. Ministry of Forests Cruising Manual 1991, Section 2.

Layers 2, 3, 4 (Trees less than 12.5 cm dbh)

To collect information on trees in layers 2, 3 and 4, smaller subplots must be established at **each** cruise plot centre. A 0.01 hectare (5.64 m radius) subplot (or 0.02 ha [7.98 m radius] if less than 6–8 stems per layer) should be established. The Pre-Stand Tending Survey Form (FS 748) can be used to collect information on trees 7.5–12.4 cm dbh (layer 2), trees 1.3 m in height to 7.4 cm dbh (layer 3), and trees less than 1.3 m in height (layer 4). Prism sampling is not recommended for the smaller stems in layers 2, 3 and 4.

The cruise should collect information on the total number of trees found in each size class by species, based on Regional standards. At every fourth plot, information is collected for one sample tree for each of layers 2, 3 and 4. The sample tree that represents an average of all trees in each layer in the plot is chosen and the following information is tallied:

- Species.
- dbh (to 0.1 cm, except layer 4).
- Height (metres).
- Age (years).
- Live crown (percent).
- Periodic dbh increment for the last ten years for layers 2 and 3 (a "hammer" increment boring is sufficient).

Summaries

When the field portion of the cruise is complete, a two-phase compilation must be prepared.

Stand and stock tables should be compiled using the cruise data for all layers. This will show total stems per hectare. Basal area and volume per hectare can then be calculated by diameter class. A graph depicting the total number of trees/hectare by 5-cm dbh classes can be created (see Figure 1 on page 12) using stand tables (see Table 1 on page 13) . The data from the Pre-Stand Tending Survey Form, the number of trees in layer 2, 3 and 4, must also be plotted.

Structure Goals

A second graph line is then drawn to reflect the desired diameter distribution goal — a desired number of trees/hectare in each diameter class after harvesting. This becomes the stand structure goal (see Appendix 1 for a description of methods commonly used to develop stand structure goals). When developing stand structure goals, forest managers must understand the progression of trees in the smaller diameter classes into larger diameter classes over time and the annual diameter or basal area increment. Care must be taken to ensure there are sufficient trees being recruited into the larger diameter classes to provide viable harvest conditions for future cutting cycles.

Deficits/Surpluses

Deficits and surpluses in the various diameter classes should be identified. The number of trees should be allowed to increase in the diameter classes that are below the diameter distribution goal by leaving greater numbers in the next smaller diameter class with a surplus of stems. Cutting should be limited to those diameter classes with surplus trees.

The difference between the pre-harvest diameter distribution line and the diameter distribution goal represents the stems per hectare that should be cut. These figures are converted to percentage cut/leave factors and then the compiling agency prepares a final compilation, with volumes or basal area modified by diameter on that basis. An example calculation is shown on page 13.

Ensure Sufficient Leave Trees

When choosing the maximum diameter and the minimum diameter to be cut, and when developing the desired diameter distribution goal or stand structure goal for a stand, forest managers should ensure that:

- Sufficient healthy trees in the layer 2, 3 and 4 classes exist to provide future harvests and maintain genetic diversity.
- The cutting plan states the minimum basal area/hectare and volume/hectare to be left after harvest. Many districts have well-defined residual stand structure goals. For the drybelt Douglas-fir zone, existing guidelines suggest retaining 50 to 75% of the stand volume and basal areas from 15 to 25 m^2/ha.
- Sufficient healthy large diameter (layer 1) trees are left to provide shade and viable cone production.
- The final stand density profile accounts for anticipated losses from logging damage.
- Wildlife, water, recreation, and other resource objectives have been accommodated.

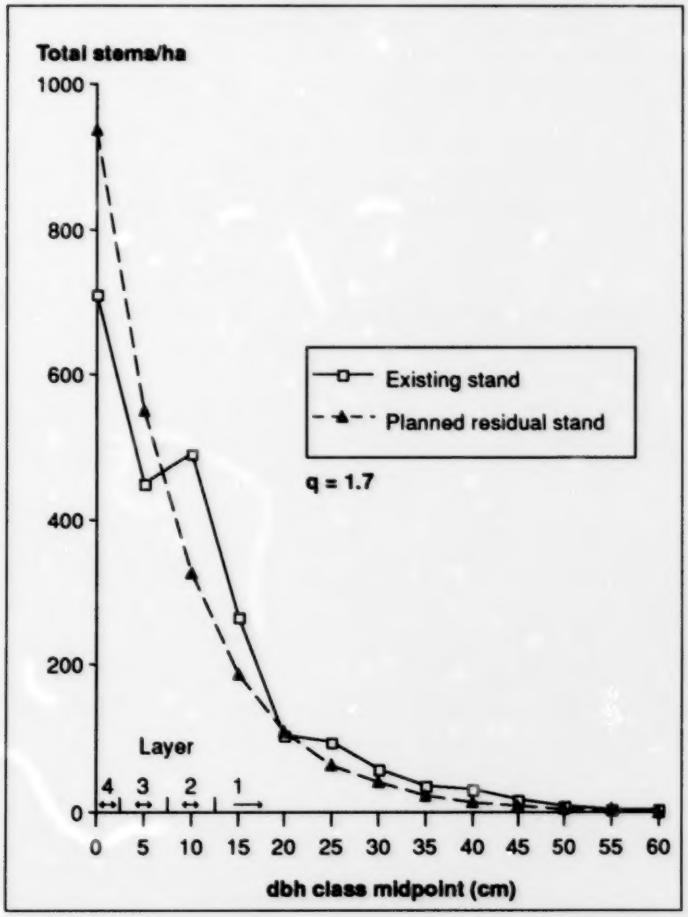


Figure 1. Density (stems/ha) in the existing stand compared to the planned residual stand.

Table 1. Determination of cut volume

Example Management Goals and Stand Conditions

Management Goals:

Minimum basal area to be left: 20 m^2/ha (based on dbh classes 12.5 cm and greater)
Starting point for inverse-J curve: 60 cm
Stand structure goal: q = 1.7
Minimum diameter to be cut: 12.5 cm

Stand Conditions:

Layer	dbh Class Midpoint (cm)	Existing Stand			Planned Stand (q = 1.7)			Planned Cut		
		Trees/ha	BA/ha	Vol/ha	Trees/ha	BA/ha	Vol/ha	Trees/ha	BA/ha	Vol/ha
4	0	712			935			0		
3	5	450			550			0		
2	10	489			324			0		
1	15	264	4.67	24.88	190	3.36	17.94	74	1.30	6.94
1	20	105	3.30	20.89	112	3.52	22.28	0	0.00	0.00
1	25	95	4.66	32.64	66	3.23	22.63	29	1.43	10.01
1	30	60	4.24	36.76	39	2.74	23.74	21	1.50	13.02
1	35	35	3.37	30.31	23	2.19	19.74	12	1.17	10.57
1	40	30	3.77	36.44	13	1.68	16.29	17	2.09	20.16
1	45	19	3.02	32.23	8	1.25	13.38	11	1.77	18.85
1	50	10	1.96	20.94	5	0.91	9.72	5	1.05	11.23
1	55	6	1.43	16.16	3	0.65	7.35	3	0.78	8.81
1	60	6	1.70	19.79	2	0.45	5.30	4	1.24	14.50
	TOTAL	2259	32.11	271.05	2269	20.00	158.36	177	12.33	114.08

Note: The basal area has been calculated using layer 1 only (trees greater than 12.5 cm dbh). Trees in layers 2, 3 and 4 may be removed due to maximum density spacing, incremental spacing, or harvesting, and therefore must not be included as part of the planned minimum residual basal area.

PRE-HARVEST SILVICULTURE PRESCRIPTION

The Pre-Harvest Silviculture Prescription (PHSP) provides the goals and objectives of stand management. All PHSP's must comply with the legislated regulations (Forest Act Part 10.1 and Silviculture Regulation April 8, 1988). The following guidelines will assist practitioners in their role of providing adequate information to properly manage areas using an uneven-aged silvicultural system.

Management Objectives

PHSP management objectives must project beyond free growing to ensure long-term management objectives are met. These should consider the following:

- Non-timber objectives (see page 4).
- Timber objectives:
  - state intent to manage on uneven-aged basis
  - state species objectives (conifer, deciduous, mixed wood) and product objectives (sawlog or pulplog)
  - expected volume to harvest first entry
  - expected growth rate
  - B-level stocking.

Site-specific management objectives

Identify the management objectives that pertain to the particular area, then specify the actions and activities to grow the desired stand.

The PHSP should specify the minimum basal area/hectare and volume/hectare to be left standing on the proposed cutblock after harvest.

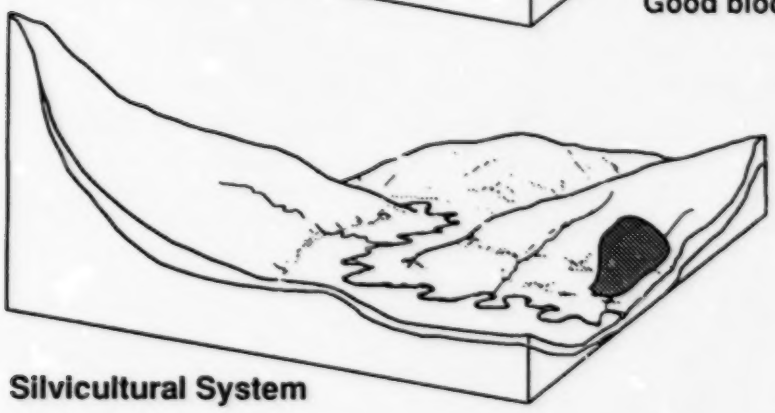
This is required to ensure that sufficient basal area and volume/ hectare is left to regenerate the stand and provide sufficient volumes for future cuttings within a reasonable time period.

Cutting cycles

The PHSP should specify the expected cutting cycle. The pre-harvest stand structure influences the options and sequence of future cuttings and silviculture activities. The cutting cycles and leave stand proposed in the PHSP must ensure sustainable future cuttings and continued regeneration of the site.

Ideally, the shape and size of the cutblock should be designed so that it can be harvested in the same manner in successive cuttings. In order to develop long-term stand structure goals, it is vital to have properly engineered and easily identifiable block boundaries, so that the same cutblock can be harvested using consistent prescriptions over time.

Good block design



Poor block design

Silvicultural System

Specify whether single tree and/or group selection harvesting is to be carried out. Note that on southern aspects, group selection may create unacceptable voids. Also consider the following points:

- Explanation why selection is preferred over other options.
- Current stand structure and stocking (expressed as basal area in each 5 cm diameter class and shown in stand/stocking tables ± graphs).
- Desired first-entry residual stocking (basal area by diameter class in stocking table or graphical format).

- Rationale for residual stocking.
- Maximum dbh to leave.
- Target diameter distribution goal expressed as "**q**".
- Leave tree characteristics (species, decay and damage, vigour, wind firmness, potential to produce seed).
- Seedbed requirements.
- Assessment of windthrow potential.

Logging Method/Constraints

Consider the following points when selecting the method of harvest:

- Marking method.
- Falling method.
- Skidding/yarding equipment.
- Seasonal constraints, site degradation standards, etc. (as for clearcuts).

Logging constraints related to block size/configuration, aesthetics, wildlife values, recreation use, range use or other considerations should be documented as outlined in the silviculture regulation.

Characteristics of leave trees

Quality characteristics of leave trees must be stated in the PHSP. Leave trees should be of superior form and vigour where possible. Leave trees should be windfirm, capable of producing viable seed, and have a low risk for pathological development. Trees of poor form may be left if extraction would leave a **void** or if the tree has value for non-timber purposes, such as wildlife.

After the pre-harvest cruise, the diameter class distribution of the pre-harvest, and the planned post-harvest stand should be displayed as a graph or as a stand and stock table.

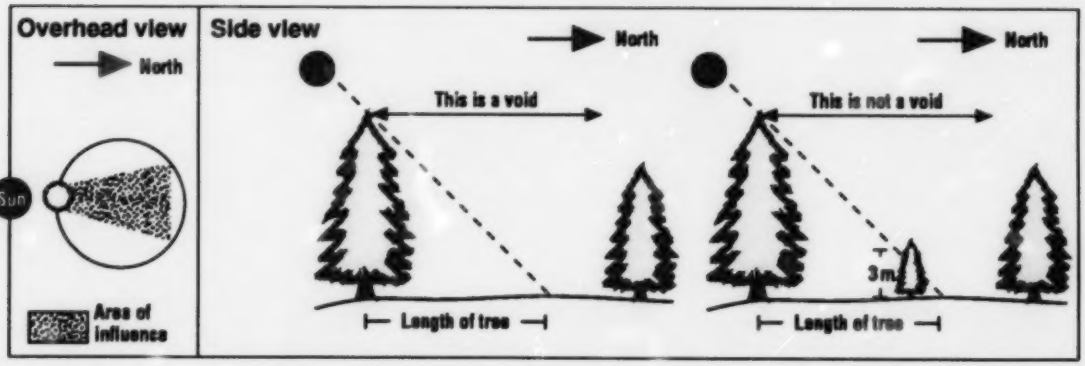
Inverse-J curve graphs or tables, detailing the number of pre-harvest and proposed post-harvest trees in each diameter class, should be attached to the PHSP. The proposed post-harvest stand distribution curve becomes the stand structure goal for the stand — a desired total number of leave trees by diameter class.

Voids

Shade is often a critical factor affecting regeneration establishment in the drybelt Douglas-fir area. This is especially pronounced on flat or southern exposures. For this reason, no voids should be created by the licensee greater than 1 tree length on the south or southwest side of an opening.

Operationally this means that on flat or southern exposures, if a tree considered for felling has no trees (3 m in height or greater) within one tree length to its north to northeast, an unacceptable amount of shadeless area (void) would be produced and an alternate tree should be chosen (see diagram below).

The maximum allowable size of a void must be stated in the PHSP. This requirement may be waived if the PHSP identifies specific reasons for the creation of larger voids (i.e., moist-wet site series, the development of mule deer winter range, or presence of insect-killed trees).



Skid Trails and Landings

If appropriate, include a discussion regarding the following points:

- Will roads and landings be maintained as permanent structures?
- Are special measures required to ameliorate impact on other site resources?
- Are designated skid trails required?

If new skid trails and landings are developed during each harvest, and if they are not stocked before the next cutting cycle, there will be an undesirable accumulation of unproductive land. Previously located and reused skid trails are strongly recommended. Future cutting cycles and access should be considered in skid road, trail and landing location.

Site disturbance

Specify the maximum allowable level of soil disturbance through roads, landings and skid trials. Refer to guidelines for soil disturbance (Interior Forest Harvesting Site Disturbance Guidelines and Vancouver Region Site Degradation Guidelines).

Pest Risks

The PHSP must make an accurate assessment of pest risks and commit to appropriate strategies to manage expected losses of trees or stand structure. In areas with a high incidence of root rot the use of uneven-aged management may not be acceptable.

Silviculture Plan

The silviculture plan should include the harvesting and silviculture treatments and activities that will create a desired stand structure goal by the end of the PHSP obligation. The silviculture plan should ensure that stand management will either maintain, promote and/or establish a multi-diameter or uneven-aged stand structure.

Part of the silviculture plan is to harvest and manage the stand to create the desired number of total trees by diameter class — an inverse-J curve. (Figure 2 is an example of a stand structure goal.)

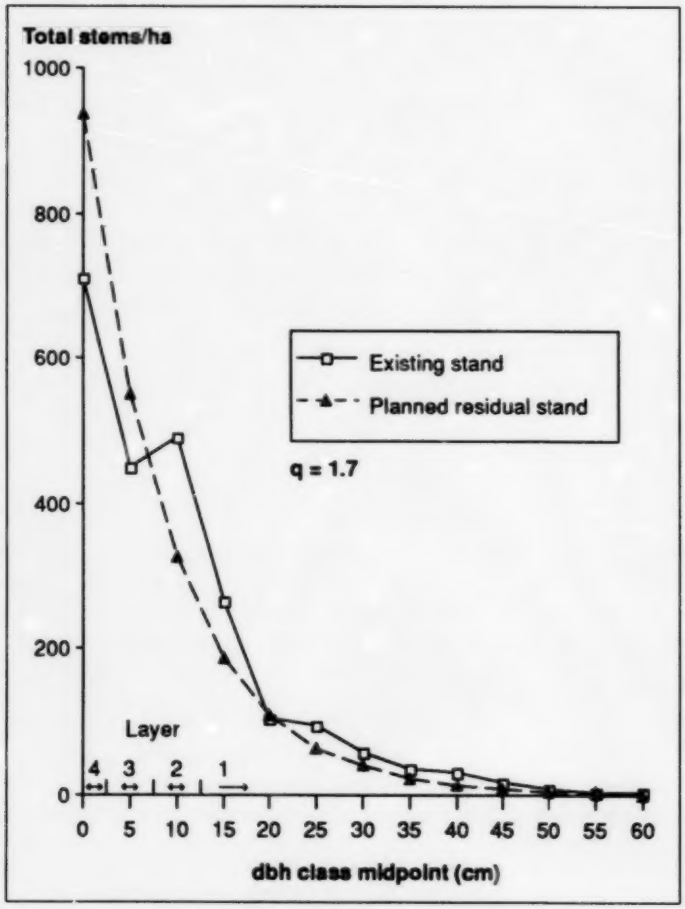


Figure 2. Diameter distribution for uneven-aged stand.

Free Growing Stocking Standards

Another part of the silviculture plan is to ensure that adequate stocking (site occupancy) occurs over the entire cutblock. All layers in a selection logged area can contribute to the stocking status and free growing determination of the area. For each area, a set of 4 stocking standards applies. This is based on the premise that the 4 different layers in the stand structure occupy and require different amounts of growing space. Each layer can completely stock the stand or may contribute to the overall stand stocking.

Layer Target and Minimum Stocking Standards: Submesic – Subhygric Sites

Layer	dbh Class	Layer Target (well-spaced trees)	Layer Minimum (well-spaced trees)	Warning flags by Layer
1	12.5 cm and greater	600	300	a
2	7.5–12.4 cm	800	400	a
3	1.3 m–7.4 cm	1000	600	b Max Density flag
4	0 to < 1.3 m in height	1200	700	c Regen flag

Layer Target and Minimum Stocking Standards: Xeric (and Hygric Sites)

Layer	dbh Class	Layer Target (well-spaced trees)	Layer Minimum (well-spaced trees)	Warning flags by Layer
1	12.5 cm and greater	400	200	a
2	7.5–12.4 cm	600	300	a
3	1.3 m–7.4 cm	800	400	b Max Density flag
4	0 to < 1.3 m in height	1000	500	c Regen flag

Notes on warning flags:

a. If there is an absence of this layer or poor diameter distribution of trees in this layer then the prescriber must note this in the PHSP. Actions to improve stand structure should be specified in the PHSP.

b. If the pre-harvest cruise indicates that total tree density exceeds maximum density guidelines, the prescriber must specify in the PHSP that spacing will be a basic silviculture activity carried out on the cutblock unless concern for non-timber values indicates otherwise. Until a correlated maximum is provided, maximum density values will follow Regional guidelines for layer 3.

c. If the pre-harvest cruise indicates that there is an absence of or insufficient regeneration in this layer, then the prescriber must specify the actions, such as site preparation or planting, to be carried out to increase the number of trees in this layer. **If no actions to increase density are prescribed for this cycle, reasons must be documented in the PHSP.**

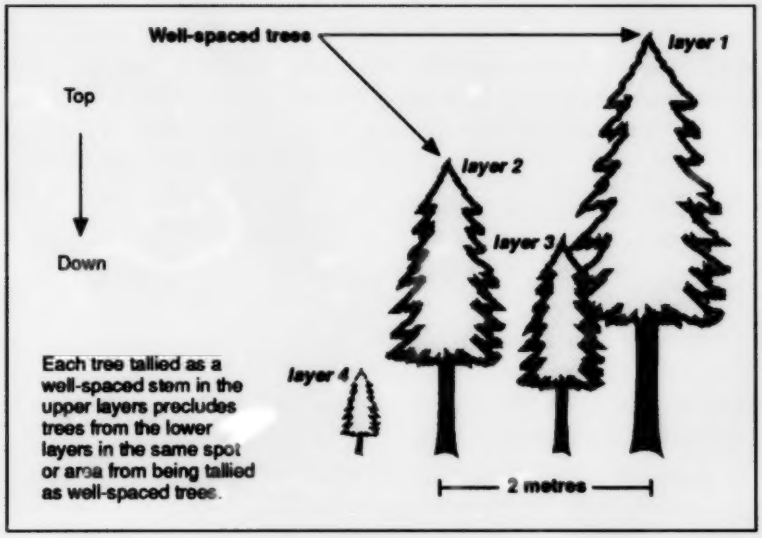
Appendix 2 contains an example of how these stocking standards are entered onto the Major Licensee Pre-harvest Obligation Definition form (FS 708A). Details on form completion are available in the *Guide to Completing the FS 708*.

Application to other biogeoclimatic zones

These stocking standards were designed for use in uneven-aged management of drybelt Douglas-fir in the Interior Douglas-fir zone. Stocking standards could be developed specifically for other zones. The approach and format may be similar but applicability must be determined by zone.

How do these stocking standards work?

To determine the stocking status of a stratum, surveyors collect data on all four layers on each survey plot. On each survey plot the surveyor tallies the number of well-spaced trees in each layer beginning with layer 1, then layer 2, layer 3 and finally layer 4. Each tree tallied as a well-spaced stem in the upper layers precludes trees from the lower layers in the same spot or area from being tallied as well-spaced trees.


Well-spaced trees
layer 1
Top
layer 2
layer 3
Down
Each tree tallied as a well-spaced stem in the upper layers precludes trees from the lower layers in the same spot or area from being tallied as well-spaced trees.
layer 4
2 metres

After establishing sufficient plots to adequately describe the stratum, a summary of the survey is made. A summary is made of the number of well-spaced trees in each layer. For example, on mesic sites the area will be considered satisfactorily stocked if one of the following applies:

1. The number of well-spaced trees (WS) in any layer exceeds the minimum stocking standard (MSS) for that layer.
2. The combination of WS in layers 1 and 2 combined exceeds the MSS for layer 2 (400 WS/ha).
3. The combination WS in layers 1, 2 and 3 combined exceeds the MSS for layer 3 (600 WS/ha).
4. The number of WS in all four layers combined exceeds the MSS (700).

Warning flags

Prescribers must note if one or more of the warning flags or conditions is present in the stand at the time of the preparation of the PHSP. In the PHSP, the prescriber must either:

- Prescribe harvesting and/or silviculture activities to correct or improve the stand structure.
- Describe the present stand structure and the reasons why no obligations to correct the post-harvest stand structure are required.

For example, the PHSP may state that there is an absence of trees or insufficient numbers of total trees per hectare in layer 4. Excessive densities and overstocking in layers 2 and 3 have resulted in unavailable ground for further natural regeneration. No regeneration obligations for layer 4 would be prescribed, but a maximum density obligation for layer 3 may be prescribed.

Minimum inter-tree distance

To be tallied as well-spaced, trees should be the following minimum distance from each other:

- no minimum inter-tree distance for layer 1 trees (i.e., all layer 1 trees are well-spaced trees).
- 2 metres for trees in layers 2, 3 and 4 unless otherwise specified.

Maximum density

The PHSP must state the maximum density of trees between 1.3 m in height and 7.4 cm in diameter (layer 3). Where post-harvest densities exceed this maximum density, the agency responsible for Basic Silviculture must carry out spacing on at least the layer 3 trees to reduce the density below the prescribed maximum. Until a correlated maximum is provided, maximum density values will follow Regional guidelines for layer 3.

As part of the spacing treatment, the agency may space other layers to improve stand structure, but Basic Silviculture obligations relate only to layer 3.

Preferred and acceptable species

The PHSP must specify the desired preferred and acceptable tree species. Prescribers should select the appropriate tree species by using regional guidelines and their local knowledge. If a shift from the pre-harvest tree species composition is proposed, the prescriber must identify the reasons for the change.

Well spaced (WS)

A well-spaced (WS) tree must meet all the following criteria:

- A **preferred** or **acceptable** species.
- At least the **minimum inter-tree distance** from all other **well-spaced trees** (no minimum inter-tree distance for layer 1 trees).
- **At least 15 cm tall.**
- Have acceptable form and vigour.
- Meet regional guidelines.

Free growing (FG)

The tree must be 5 years on-site and at least 40 cm tall, well spaced, and also be at least 125 percent of the height of competing vegetation within a 1-metre radius of the bole of the crop tree.

Regeneration delay

The PHSP must specify the maximum allowable time from commencement of harvesting within which the stand must be satisfactorily stocked.

1. The maximum regeneration delay period recommended for these sites is 7 years from the commencement of harvest.
2. Regeneration delay can be met immediately **after harvest** if the residual stand has no significant damage, or pest problems, and is stocked. Caution: Regeneration in drybelt fir frequently declines immediately after harvesting opens the stand. If stocking is close to the minimum, monitor it.

Free growing assessment dates

The PHSP must specify the earliest and latest free growing assessment dates. The choice of free growing assessment dates is based on the stand structure:

- The earliest free growing assessment date is **5 years post-harvest,** if new regeneration is not required to meet regeneration delay criteria.

- If the establishment of new regeneration is an obligation, the **earliest free growing assessment date** is when the new regeneration has been on-site for 5 years, and is a minimum of 40 cm tall.
- The **latest free growing assessment date** is 15 years after the commencement of harvest to allow for diameter and height response to harvesting and subsequent silviculture treatments.

Target leader growth

Target leader growth should be based on regional guidelines.

Keeping It Simple

Persons developing PHSP's and associated Cutting Permits should ensure that only one stand structure goal and only one set of stocking standards are developed for each cutblock proposed for harvest.

If more than one stand structure goal and set of stocking standards are developed (i.e., more than one PHSP treatment unit within a cutblock), the management and measurement of stand layers and parameters, and the reporting of obligation(s), will be extremely difficult and result in excessively complicated administration.

CUTTING PERMIT

The Silviculture Interpretations Working Group recommends the following information be included in all cutting permits in order to consistently administer harvesting of uneven-aged stands:

- Cutting specifications.
- Trees reserved from cutting.
- Logging method.
- Timing.
- Utilization standards.
- Roads.
- Landing and skid trail development.
- Soil protection.
- Rehabilitation of landings and roads.
- Marking when needed.

The Cutting Permit or the Timber Sale document regulates implementation of the harvesting phase of the PHSP. In these guidelines the term "Cutting Permit" is used to refer to the Cutting Permit (used in Major Licence Timber Sales) and the Timber Sale document (used in Small Business Timber Sales).

The Cutting Permit normally provides the general harvesting specifications used to administer one or more cutblocks. To ensure that each cutblock is harvested as prescribed, a copy of the PHSP for each cutblock should be referenced and attached to the Cutting Permit.

The Cutting Permit must reflect the PHSP objectives and be synchronized with it; duplication of information should be avoided.

Cutting Specifications

Utilization and cutting specifications are to be submitted as a separate schedule within the Cutting Permit under section 5.0 (Utilization standards and cutting specifications) for Major Licences and section 4.0 (Utilization standards and forest practices) for Timber Sale Licences (minor).

Cutting Permits use specific clauses that must hold up under legal scrutiny.

The cutting specifications must be based on a stock and stand table and associated inverse-J curve graph outlined in the PHSP. Specifics by 5-cm dbh class of the pre-harvest stand, what is to be cut, and what to leave, are the basis for the cutting specifications. A minimum basal area to be retained on-site should be provided. See examples on page 13.

For each cutblock in the Cutting Permit, a simple selection criterion should be specified to be used by fallers in selecting the trees to cut. As a guideline, a maximum of four cutting rules may be used. For example:

- Cut only trees between 22.5 and 60 cm dbh.
- dbh 22.5–27.5 cm: cut 2 trees in 5 (40%).
- dbh 27.6–37.5 cm: cut 1 tree in 3 (33%).
- dbh 37.5–57.5 cm: cut 1 tree in 2 (50%).

Trees reserved from cutting

The Cutting Permit must specify the required quality and condition of each stand after harvest. Except for wildlife concerns those trees reserved from cutting should have the following characteristics:

- Healthy live crowns (greater than 33% of the total height).
- Good quality, containing no major scars, forks, nor broken tops (risk group 1).
- Good form with moderate to high vigour.
- Free of serious pest damage.
- Removal would create an unacceptable void.
- Windfirm.

Logging method

The Cutting Permit must specify the general method that will be employed to harvest the cutblock to achieve the objectives of the PHSP. It will also specify any restrictions on the type(s) of machinery that may be used (e.g., restrictions on the width of skidders or feller bunchers) due to the impact they may have on the site. The Cutting Permit may also require two-pass falling to harvest the area, i.e., one cut to remove the majority of the trees and one cut to remove trees used for rub trees during skidding.

Timing

In areas with special concerns, the Cutting Permit should specify when each of the logging phases (Road/landing construction, Felling, Skidding, and Hauling) are expected to start and finish (e.g., clause | N-9 Restricted logging period |). The Cutting Permit may specify the timing of activities:

- After completion of critical growth periods of the stand.
- During periods when soil compaction can be minimized (e.g., frozen ground).

Utilization standards

The Cutting Permit schedule must specify the utilization standards for waste and felled timber under sections 4 or 5 depending upon tenure. The appropriate clause (clause section D) should be used to specify the maximum stump height, maximum top diameter of waste trees and minimum size of trees to be utilized.

Roads

The Cutting Permit should specify for each cutblock the location, length, width and number of permanent roads to be established (clause | R-1 Plan and specifications – Approval |).

Landing and skid trail development

Skid trail development should be kept to a minimum with existing trails utilized wherever possible.

A detailed logging plan should specify the maximum size, number and location of landings. (See clause | L-1A Logging plan submission Forest Office Approval |.)

The logging plan should specify maximum skid trail width, minimum distance between trails, and skid trail alignment. It should also specify any trail marking requirements prior to logging. Pre-located trails and a layout sketch map should be required for inexperienced operators.

The logging plan must specify if the landings and skid trails are to be permanent.

Soil protection

The licensee shall adhere to the harvesting guidelines in the PHSP to prevent an unacceptable level of soil disturbance.

Rehabilitation of landings and roads

The Cutting Permit must also specify if rehabilitation of roads, skid trails, and landings will be required on completion of harvest. If rehabilitation is required, the cutting permit must specify the actions to be taken for rehabilitation. This information is set out in the schedule.

Marking

For each cutblock, the Cutting Permit must state the method of selecting cut and leave trees. Two options are available: **individual tree marking** prior to cutting, or **faller selection**.

Marking

If tree marking is chosen, it is valuable initially, until fallers and operators are trained and experienced in tree selection. Some level of marking should be conducted on each cutting authority as a control and comparison to faller selection. It is important to ensure markers are properly trained in silviculture and falling.

Standardize marking to paint at dbh and below stump height on two sides of the tree. Marking the trees to cut is usually the most efficient method, since fewer stems are cut than left.

Fallers have the option to leave designated trees if falling is thought to be too hazardous.

Faller selection

The key to successful faller selection is close supervision from an early stage, continuing throughout the harvesting phase. Clear instructions and education of fallers and skidder operators in stand management objectives are crucial to developing the desired stand.

Consider using faller selection in any of the following circumstances:

- When stands have a large range in diameters and heights.
- When experienced fallers are available.
- When past performance has been in accordance with cutting plans.

Group selection

The desired characteristics for each cutblock should be stated in the logging plan. In some cutblocks the manager may prefer a group selection approach to marking and felling, with tiny openings and clumps of leave trees. This approach may provide:

- More forage production in openings.
- More thermal cover for wildlife available in thickets.
- Pest and disease mitigation.
- Somewhat easier and safer felling.
- Easier slash disposal.
- Improved microclimate for regeneration.

MONETARY ASSESSMENTS

In addition to other standard penalties, monetary assessment for violation of the Cutting Plan should be stated in the Cutting Permit document. These may include monetary assessments for:

- Overcutting or improper harvesting.
- Damage to leave trees, including wildlife or large veteran trees.
- Creation of unacceptable voids.

PRE-WORK GUIDANCE FOR HARVESTERS

Guidance for Fallers

Instructions to fallers, for faller selection, or to tree markers, should cover the following:

- Objectives of the selection system.
- Explanation of simple, practical cutting rules (suggested maximum 4 cutting rules).
- Tree species to be left, in order of preference.
- The tree quality and pest damage criteria that apply.
- The maximum permitted void sizes. The agency responsible for logging the area must ensure that fallers do not log trees bordering a natural void as this reduces stand shading.
- The windfirm characteristics of leave trees — pointed crowns and "open grown" bark.
- Falling trees towards natural openings.
- Falling all trees in a herringbone fashion to the skid trails.
- The importance of the configuration of canopy closure to moderate temperature and moisture stress at the forest floor.
- Bucking, limbing and topping of felled trees in the bush prior to skidding.
- Fall skid trails, first aligning them to avoid sharp corners and to follow the terrain.
- Buck windthrow along skid trail routes prior to skid trail construction to minimize regeneration damage.
- Description of wildlife trees to be left and their purpose.

Guidance for Skidder Operators

Instructions to skidder operators should cover the following:

- Preference for small skidding equipment.
- Keeping machinery on skid trails, pulling mainline to reach trees where necessary.
- Pulling trees onto skid trails as individuals.
- Use of stumps or harvest trees as rub trees — avoiding the use of leave trees as rub trees.
- Keeping turns to a manageable size to keep within the skid trail widths.

- How to minimize unacceptable soil disturbance.
- How to create soil disturbance to encourage needed regeneration.
- How to minimize stand damage if significant amounts of dead and down material is already on the cutblock.
- Rub trees and damaged trees that will not survive to the next cutting cycle, or are scarred and susceptible to pests, to be removed last.
- Avoiding destruction of habitat provided by features such as large debris or clumps of regeneration.

HARVEST MONITORING

The successful application of the selection system requires more skill and closer administration than even-aged systems. Early and regular monitoring of faller selection is crucial.

A properly prepared PHSP and Cutting Permit are necessary to document and communicate standards and contract conditions to those carrying out selection harvesting.

In addition to clear and complete instructions to fallers, close supervision and monitoring of the harvesting phase is a crucial element in creating the desired stand. Prism sweeps and tree tallies in recently felled areas will indicate whether problems are being created.

The following must be assessed during harvest:

- Overcutting of a stand component.
- Damage to the leave trees or regeneration.
- Ground disturbance to facilitate natural regeneration (if no site preparation is planned). Determination of excessive disturbance is handled under the Interior Forest Harvesting Site Disturbance Guidelines and the Vancouver Region Site Degradation Guidelines.
- The creation of unacceptable voids.
- Tree selection.
- Skid trail width and placement.
- Wildlife tree protection.

By concentrating on leaving the proper residual stand, managers will ensure an adequate growing stock to produce future yields on the planned cutting cycle.

Improper marking, cutting of unmarked trees, and damage to residual trees can combine to diminish the effectiveness and/or productive potential of the stand structure and deplete the growing stock, thus defeating the objective of an uneven-aged stand.

POST-HARVEST ASSESSMENT

To determine if the cutting objectives were met, a 3-step assessment procedure is provided:

1. Walk through the area.

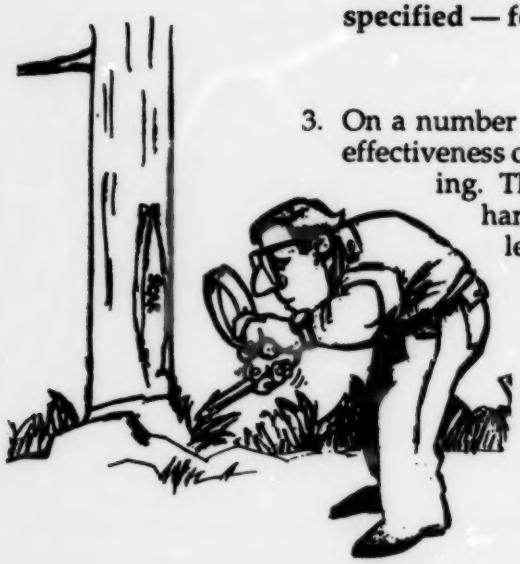
   If it appears to fit the criteria set out in the PHSP and cutting permit — stop — the post-harvest assessment is complete.

   If there is concern — go to No. 2.

2. Check the leave or residual Basal Area for layer 1 by putting in randomly located prism plots at a density of one per hectare throughout the stand:

   If the residual basal area is greater than or equal to the minimum basal area specified — stop.

   If the residual basal area is less than the minimum basal area specified — follow the timber trespass policy.



3. On a number of cutblocks, the Ministry may wish to assess the effectiveness of the level of supervision provided during harvesting. This will be done to confirm, through a formal post-harvest cruise, that stand components prescribed to be left have not been eliminated through logging. These cruises can also be used to collect important diameter distribution data which can be used for growth and yield purposes. The cruise data can be compiled and compared to the pre-harvest and planned diameter distribution curves (see Figure 3 and Table 2). Determine if a new prescription is required to rectify serious problems.

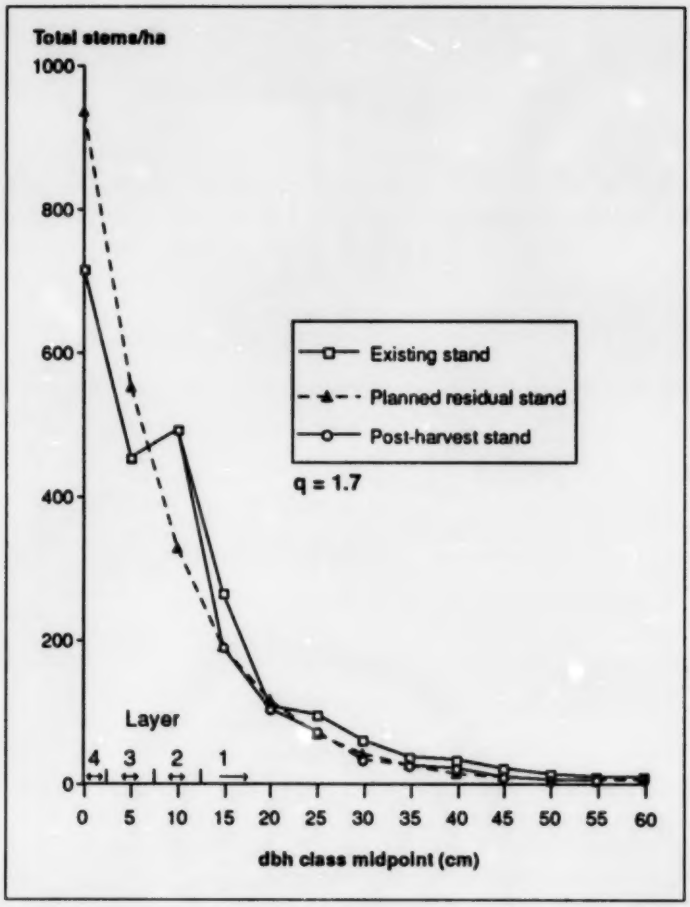


Figure 3. Inverse-J curves for pre-harvest, planned and actual post-harvest stand.

Table 2. Statistics for pre-harvest, planned and actual post-harvest stand

Layer	dbh Class Midpoint (cm)	Existing Stand Trees/ ha	Existing Stand BA/ ha	Existing Stand Vol/ ha	Stand Structure Goal (q = 1.7) (Maximum diameter 60 cm) Trees/ ha	Stand Structure Goal (q = 1.7) (Maximum diameter 60 cm) BA/ ha	Stand Structure Goal (q = 1.7) (Maximum diameter 60 cm) Vol/ ha	Planned Stand (q = 1.7) Trees/ ha	Planned Stand (q = 1.7) BA/ ha	Planned Stand (q = 1.7) Vol/ ha	Planned Cut Trees/ ha	Planned Cut BA/ ha	Planned Cut Vol/ ha	Actual Cut Trees/ ha	Actual Cut BA/ ha	Actual Cut Vol/ ha	Post-harvest Stand Trees/ ha	Post-harvest Stand BA/ ha	Post-harvest Stand Vol/ ha
4	0	712			582.62			935			0			0			712		
3	5	450			342.72			550			0			0			450		
2	10	489			201.60			324			0			0			489		
1	15	264	4.67	24.88	118.59	2.10	11.18	190	3.36	17.94	74	1.30	6.94	76	1.34	7.16	188	3.32	17.72
1	20	105	3.30	20.89	69.76	2.19	13.88	112	3.52	22.28	0	0.00	0.00	5	0.16	0.99	100	3.14	19.90
1	25	95	4.66	32.64	41.03	2.01	14.10	66	3.23	22.63	29	1.43	10.01	25	1.23	8.59	70	3.44	24.05
1	30	60	4.24	36.76	24.14	1.71	14.79	39	2.74	23.74	21	1.50	13.02	29	2.05	17.77	31	2.19	18.99
1	35	35	3.37	30.31	14.20	1.37	12.29	23	2.19	19.74	12	1.17	10.57	11	1.06	9.52	24	2.31	20.78
1	40	30	3.77	36.44	8.35	1.05	10.15	13	1.68	16.29	17	2.09	20.16	12	1.51	14.58	18	2.26	21.87
1	45	19	3.02	32.23	4.91	0.78	8.33	8	1.25	13.38	11	1.77	18.85	10	1.59	16.96	9	1.43	15.27
1	50	10	1.96	20.94	2.89	0.57	6.05	5	0.91	9.72	5	1.05	11.23	7	1.37	14.66	3	0.59	6.28
1	55	6	1.43	16.16	1.70	0.40	4.58	3	0.65	7.35	3	0.78	8.81	3	0.71	8.08	3	0.71	8.08
1	60	6	1.70	19.79	1.00	0.28	3.30	2	0.45	5.30	4	1.24	14.50	3	0.85	9.90	3	0.85	9.90
	TOTAL	2259	32.11	271.05	1413.51	12.46	98.65	2269	20.00	158.36	177	12.33	114.08	168	11.87	108.21	2100	20.24	162.83

Note: The basal area has been calculated using layer 1 only (trees greater than 12.5 cm dbh).

STOCKING SURVEY

The stocking survey is carried out on or before the expiry of the regeneration delay period. The Stocking Survey collects information to fulfil four objectives:

1. Confirm that sufficient healthy stocking has been achieved on or before the expiry of the regeneration delay period.
2. Produce an updated map label and forest cover description.
3. Develop recommendations for stand treatment.
4. Identify if any of the "flags" for layers need consideration.

A rapid walk-through of the cutblock should allow the surveyor to confirm the stratification. If there are changes to site and historical information for each stratum, the Silviculture Survey form (FS 657) is completed.

On uneven-aged strata with low variability, a sampling intensity of 5 plots per stratum or 1 plot every 3 hectares may be adequate. However, a sample design of 1 plot/hectare, laid out in a grid pattern, is recommended for strata with high variability.

For layers 1, 2, 3, and 4 a 3.99-metre radius plot (0.005 ha) is established. The Silviculture Survey Plot Card (FS 658) is used to record the plot information, by species and layer. (See Appendix 3 for example of a completed form.)

Carry out the following steps to tally information within the plot:

The maximum number of trees to be counted in each layer is determined by the target stocking standard for that layer. In the example below the target stocking standards for submesic to subhygric sites are used.

The target stocking standard is 600 well-spaced trees per hectare for layer 1. This translates into a maximum of 3 trees to be tallied as well spaced (WS) in layer 1 if a 1/200 hectare plot is used. (N.B. minimum inter-tree distance, page 22)

Begin tallying of trees from the top layer (layer 1) down to the bottom layer (layer 4).

1. Tally total trees and total conifers in layer 1.
2. Tally the number of WS in layer 1 up to a maximum of 3.
3. Tally total trees and total conifers in layer 2.
4. Tally the number of WS in layer 2 up to a maximum of 4.
5. Tally total trees and total conifers in layer 3.
6. Tally the number of WS in layer 3 up to a maximum of 5.
7. Tally total trees and total conifers in layer 4.
8. Tally the number of WS in layer 4 up to a maximum of 6.

At each plot, the surveyor must tally the number of well-spaced trees in each layer. Even though the maximum number of trees was tallied in an upper layer, the surveyor should tally the number of well-spaced trees in lower layers. Preferred and acceptable trees in lower layers can be tallied as well-spaced trees if they are at least the minimum inter-tree distance from trees counted in the upper layers.

The surveyor must also take a sample measurement of the total height and age of the trees in each layer every fourth plot.

Stocking Decisions

After establishing sufficient plots to adequately describe the stratum, a summary of the survey is made. **Each layer is first separately summarized.** After each layer has been summarized, the stocking status of the area is determined. (See example of a summary in Appendix 4.) An area will be considered satisfactorily restocked if one of the following applies:

1. The number of WS in any layer exceeds the MSS for that layer.
2. The combination of WS in layers 1 and 2 combined exceeds the MSS for layer 2 (400 WS/ha*).
3. The combination of WS in layers 1, 2 and 3 combined exceeds the MSS for layer 3 (600 WS/ha*).
4. The number of WS in all four layers combined exceeds the MSS (700 WS/ha*).

*** Minimum stocking standards (MSS) for submesic to subhygric sites.**

If a stratum is not stocked the cutblock is considered as not having met the regeneration delay period. The agency responsible must carry out silviculture activities to ensure the entire block is stocked.

Examples using stocking standards for submesic to subhygric sites:

Layer 1 MSS=300
Layer 2 MSS=400
Layer 3 MSS=600
Layer 4 MSS=700

Example 1. The survey summary indicates:

No. of trees	in layer #
320 WS	1
320 WS	which exceeds the layer 1 MSS of 300. Therefore the stand would be classed as SR.

Example 2. The survey summary indicates:

No. of trees	in layer #
200 WS	1
240 WS	2
440 WS	which exceeds the layer 2 MSS of 400. Therefore the stand would be classed as SR.

Example 3. The survey summary indicates:

No. of trees	in layer #
100 WS	1
200 WS	2
350 WS	3
650 WS	which exceeds the layer 3 MSS of 600. Therefore the stand would be classed as SR.

Example 4. The survey summary indicates:

No. of trees	in layer #
100 WS	1
200 WS	2
200 WS	3
300 WS	4
800 WS	which exceeds the layer 4 MSS of 700. Therefore the stand would be classed as SR.

Example 5. The survey summary indicates:

No. of trees	in layer #
100 WS	1
200 WS	2
200 WS	3
100 WS	4
600 WS	which is below the layer 4 MSS of 700. Therefore the stand would be classed as **NSR.**

The stocking survey also determines:

- Whether any regeneration obligations (as prescribed in the PHSP) have been fulfilled or are still outstanding. The surveyor should recommend appropriate actions to increase the density of layer 4 if required.
- Whether the maximum density (specified in the PHSP) has been exceeded for layer 3.

If the maximum density has been exceeded, the surveyor should recommend a spacing treatment for the area before the end of the free growing period.

FREE GROWING SURVEY

This survey is carried out within the free growing assessment period specified in the PHSP. The survey is conducted in the same manner as a Stocking Survey with the only addition being that each well-spaced tree is also evaluated for free growing status.

The survey also determines if the layer 3 total tree density is below the maximum density prescribed. The FS 658 is used to tally the information.

If a stratum is not free growing, or if the maximum density flag identifies unfulfilled obligations, the cutblock is considered not free growing. The agency responsible must carry out silviculture activities to ensure the cutblock is free growing before being relieved of its obligations.

REPORTING

The PHSP standards and the harvesting/silviculture activities and land status must be detailed and submitted to the Major Licence Silviculture Information System (MLSIS) or the History Records and Inventory Database.

For Major Licensees

(For areas denuded after October 1, 1987)

The Major Licence Silviculture Information System, Pre-Harvest Obligation Definition, Form "A", FS 708A must be completed and contains information from the approved PHSP. If the PHSP information is submitted on a Ministry PHSP form (FS 711C 89/5), submission of a Form A is not required as Ministry staff can enter all required MLSIS data directly from the shaded fields on the PHSP form. Procedures for completion are found in the *Guide for Completion of FS 708 Forms* available at all District Offices.

The standard FS 708A is presently being modified for use in uneven-aged stands. When completing this form a new column for layer must be added to the form. For each treatment unit (TU) within a block, 4 separate layers must be identified. The respective stocking standards can be entered for each layer (see example in Appendix 2). Information can be put in directly from the PHSP document, if the Ministry of Forests form is used.

Form FS 708B must be filled out when harvesting or silviculture activities such as natural regeneration or juvenile spacing have been completed.

Form FS 708C is used to report land status and forest cover attributes at the post-harvesting, regen delay and free growing periods. A completed forest cover map must accompany the submission of the FS 708C (see example in Appendix 5).

Designations of layers for inventory are those specified for Forest Cover Attribute Lists. Pest information must be coded using the codes from the FS 747. The FS 708 forms must be submitted to the District Manager within the time periods specified in the silviculture regulations.

For Ministry Responsible Areas

Forest cover attribute form

Upon completion of the Post-harvest Assessment, Stocking Survey and the Free Growing Survey, the attribute lists must be updated.

General procedures for the completion of attribute lists are printed on the FS 922 forms and are outlined in Chapter 3 of the Inventory Manual. Completed lists should be submitted to the District Resource Inventory Officer.

For multiple-layered stands, report two layers only for inventory purposes on the Forest Cover Attribute form (FS 922).

The first layer to be described on the form is the layer (either 1, 2, 3 or 4) that will form the next harvestable crop.

The forest cover attributes for that layer, such as commercial tree species, age and height of the leading species and density of the layer, is the first line of data to be described on the attribute form.

The layer that will make up the next harvestable crop in the cutting cycle should be designated as "1" for "top layer" and rank "1" as the layer that is contributing the most volume towards the next entry. Growth and yield projections for the stand will be derived from this layer.

A second layer, which will make up the following crop, should also be described on the FS 922.

The attributes of the next layer such as species, age, height and density would be described on the line below the rank 1 layer. This 2nd layer should be designated as "2" for "next layer" and should be entered as rank "2".

If more than 25% of the volume of the original stand was harvested, a stocking class "R" must be attached to the inventory label. This will ensure that when growth and yield simulations are carried out on layer 1, the predicted future yields will be reduced on uneven-aged areas.

The Inventory attributes of the various layers of a selection logged area should be described separately and never lumped together.

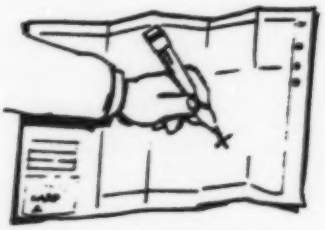
History records

Upon completion of the PHSP, harvesting, silviculture activity, or any land status or forest cover change, the History Records must be updated.

In Section I of the History Records, the inventory component should be completed using the attributes of the rank 1 layer. The silviculture component of Section I should be completed using the attributes of the rank 2 layer.

Maps

On completion at the harvesting, regen delay, and free growing assessment dates, an accurate map showing the stratification and forest cover labels for the opening must accompany the reports.



EPILOGUE

Through these procedures the Forest Service intends to promote continued improvement in the stewardship of these particular forests. These forest types require special care to ensure their sustainability for both timber and other resource values.

APPENDIX 1. Developing Stand Structure Goals

When the field portion of the cruise is complete, a stand and stock table must be prepared detailing the existing stand, the planned harvest and the planned or residual stocking level.

Existing Stand Structure

Produce a stand and stock table using the cruise data. This will show the stems per hectare and volume or basal area per hectare by 5 cm diameter class.

To calculate BA/ha (m^2/ha) for each diameter class the following formula should be used:

$$BA/ha = \pi \times (dc/2)^2/10{,}000 \times stems/ha$$

dc = the midpoint in the diameter class (minimum 15 cm).

To estimate volume per ha, the BA/ha is multiplied by the average height for the diameter class then divided by 3 (see Table 3).

Table 3. Existing stand conditions

Layer	dbh Class Midpoint (cm)	Existing Stand Trees/ha	BA/ha	Vol/ha	Stand Structure Goal (q = 1.7) (Maximum Diameter) Trees/ha	BA/ha	Vol/ha	Planned Stand Trees/ha	BA/ha	Vol/ha
4	0	712								
3	5	450								
2	10	489								
1	15	264	4.67	24.88						
1	20	105	3.30	20.89						
1	25	95	4.66	32.64						
1	30	60	4.24	36.76						
1	35	35	3.37	30.31						
1	40	30	3.77	36.44						
1	45	19	3.02	32.23						
1	50	10	1.96	20.94						
1	55	6	1.43	16.16						
1	60	6	1.70	19.79						
	TOTAL	2259	32.11	271.05						

Residual Stand Structure

The determination of residual stand structure goals involves the specification of the following:

- Residual stocking level in terms of basal area per hectare (B-level or greater).
- Maximum tree size class.
- Diameter distribution goal (setting "q").
- Minimum tree size to be reserved from cutting.

When developing stand structure goals, managers must understand the progression of trees in the smaller diameter classes into larger diameter classes over time. Managers must also ensure there are sufficient trees being recruited into the larger diameter classes to provide viable harvests in future cuttings.

Residual Stocking Goal (B)

The residual stocking goal is defined in terms of basal area (BA) that must be maintained after harvest to provide adequate growth. Residual stocking should closely approximate the "B-level," i.e., the minimum stocking at which residual trees fully occupy the site. Note that there is a wide range of stocking that will yield essentially the same volume. At lower stocking levels the volume is simply concentrated on fewer stems.

The minimum basal area per hectare or volume per hectare to be left after harvest must be stated in the PHSP. Many districts have well-defined residual stand structure goals. For example, in the drybelt Douglas-fir zone, some managers retain basal areas from 15 to 25 m^2/ha and 50 to 75% of the stand volume.

To calculate minimum leave basal areas for B-level stocking, there are a variety of methods and stocking guides/charts that may be considered. For one method of calculating minimum basal area to achieve B-level stocking, refer to: Drew and Flewelling, 1979. *Stand Density Management: An alternative approach and its applications to Douglas-fir plantations*. For. Sci. Vol. 25, No. 3, 1979. The following example uses 20 m^2 as the "B-level" stocking.

Maximum diameter (D)

To set up a diameter distribution goal, you must first decide on the maximum diameter size tree to be left after each cut. The maximum diameter size chosen will be dependant upon site quality, measured and projected diameter increment, importance of forest uses other than timber production, silviculture objectives and timber markets. The maximum diameter chosen is used as the starting point for the diameter distribution using "q".

Threshold diameter class

The minimum or threshold diameter class or minimum diameter class must be identified. The minimum diameter class selected will be a function of product objectives and current market conditions, as well as the need to regulate the number of trees in the sub-merchantable diameter classes. The higher the threshold diameter, the greater the proportion of the stand that will be unregulated. For the following example a 15 cm minimum was used, which translates to harvesting down to 12.5 cm dbh.

Diameter Distribution Goal (q)

To derive a diameter distribution goal, a widely accepted procedure is to use the quotient (called "q") between numbers of trees in successive diameter classes as a means of calculating the desired diameter distribution. Thus, if you were to adopt a "q" of 1.7, each diameter class would have 1.7 times as many trees as the next larger class. When the number of trees is plotted over diameter class, the distribution calculated using "q" quotients is a curve with a typical inverse-J shape.

Determination of a "q" value is not a precise calculation, but rather a procedure used to create a smooth curve representing a desired stand structure.

Quotients between 1.2 and 2.0 or, more commonly, between 1.5 and 1.8 (for 5 cm classes) have all been used, depending on existing structure. With higher "q" values, more small trees will be retained on site. With a lower "q" value more large trees will be retained on site. The example provided uses a "q" of 1.7.

Depending on the initial structure, it may take one or more cutting cycles to obtain the desired stand structure.

Developing the Diameter Distribution Curve

After selecting the residual stocking goal, the maximum diameter class, the minimum diameter class and the "q" value, the specific stand structure curve can be calculated. If the residual stocking goal is expressed in terms of basal area, the following procedure can be used to guide these calculations.

Arbitrarily assign one tree to the largest diameter class (for this example, 60 cm was used). Then, calculate the number of trees in each of the smaller diameter classes by multiplying the next larger class by "q". Table 4 shows the stand structure goals with a "q" of 1.7 and the maximum tree size as 60 cm.

Table 4. Stand structure goal using a q of 1.7

Layer	dbh Class Midpoint (cm)	Existing Stand Trees/ha	BA/ha	Vol/ha	Stand Structure Goal (q = 1.7) (Maximum Diameter 60 cm) Trees/ha	BA/ha	Vol/ha	Planned Stand Trees/ha	BA/ha	Vol/ha
4	0	712			582.62					
3	5	450			342.72					
2	10	499			201.60					
1	15	264	4.67	24.88	118.59	2.10	11.18			
1	20	105	3.30	20.89	69.76	2.19	13.88			
1	25	95	4.66	32.64	41.03	2.01	14.10			
1	30	60	4.24	36.76	24.14	1.71	14.79			
1	35	35	3.37	30.31	14.20	1.37	12.29			
1	40	30	3.77	36.44	8.35	1.05	10.15			
1	45	19	3.02	32.23	4.91	0.78	8.33			
1	50	10	1.96	20.94	2.89	0.57	6.05			
1	55	6	1.43	16.16	1.70	0.40	4.58			
1	60	6	1.70	19.79	1.00	0.28	3.30			
	TOTAL	2259	32.11	271.05	1413.51	12.46	98.65			

Use the same formula to determine BA/ha and Vol/ha as was used in Table 3.

Compare the minimum basal area per hectare (management goal — 20 m^2/ha) with the calculated BA/ha of 12.46. Use the ratio of minimum to calculated basal area to adjust the trees per hectare and associated basal area to reflect the minimum basal area goal.

Example: The minimum leave basal area is 20.0 m^2/hectare and the calculated basal area was 12.46 m^2/hectare. Therefore for the planned stand the stems per hectare for each diameter class should be increased by the ratio of 20/12.46 or approximately 1.61 times (Table 5).

Table 5. Planned stand stem distribution

Layer	dbh Class Midpoint (cm)	Existing Stand Trees/ha	BA/ha	Vol/ha	Stand Structure Goal (q = 1.7) (Maximum Diameter 60 cm) Trees/ha	BA/ha	Vol/ha	Planned Stand (q = 1.7) Trees/ha	BA/ha	Vol/ha
4	0	712			582.62			935		
3	5	450			342.72			550		
2	10	489			201.60			324		
1	15	264	4.67	24.88	118.59	2.10	11.18	190	3.36	17.94
1	20	105	3.30	20.80	69.76	2.19	13.88	112	3.52	22.28
1	25	95	4.66	32.64	41.03	2.01	14.10	66	3.23	22.63
1	30	60	4.24	36.76	24.14	1.71	14.79	39	2.74	23.74
1	35	35	3.37	30.31	14.20	1.37	12.29	23	2.19	19.74
1	40	30	3.77	36.44	8.35	1.05	10.15	13	1.68	16.29
1	45	19	3.02	32.23	4.91	0.78	8.33	8	1.25	13.38
1	50	10	1.96	20.94	2.89	0.57	6.05	5	0.91	9.72
1	55	6	1.43	16.16	1.70	0.40	4.58	3	0.65	7.35
1	60	6	1.70	19.79	1.00	0.28	3.30	2	0.45	5.30
	TOTAL	2259	32.11	271.05	1413.51	12.46	98.65	2269	20.00	158.36

Deficits and Surpluses

Deficits and surpluses in the various diameter classes should be identified. The number of trees should be allowed to increase in the diameter classes that are below the idealized diameter distribution goal, with cutting limited to those diameter classes with surplus trees. Enough trees should be left above the curve in surplus diameter classes to balance the deficit of trees in diameter classes below the target.

When balancing deficits and surpluses in the various diameter classes, ensure that:

- Sufficient healthy trees in the layer 2, 3, and 4 classes exist to provide future harvests.
- The cutting plan states the minimum basal area/ hectare or volume/hectare to be left after harvest.
- Sufficient healthy larger diameter trees (layer 1) are left to provide shade and viable seed production.
- The final stand density profile accounts for anticipated losses due to logging damage.

Hand Drawn Diameter Distribution Goals

This method should only be used by experienced personnel.

It is also possible to graph this desired diameter distribution from experience. The general inverse-J shaped curve is maintained while not actually using the mathematical "q" value calculation.

Experienced managers who understand how trees will develop and progress from one diameter class to the next, can draw the curve to "smooth-out" diameter class distributions while maintaining the general inverse-J curve.

Cutting Specifications

The difference between the existing diameter distribution and the planned stand represents the stems per hectare that should be cut (Table 6). These figures are converted to percentage cut/leave factors.

Table 6. Ratio to cut

Layer	dbh Class Midpoint (cm)	Existing Stand			Planned Stand (q = 1.7)			Planned Cut			Cut Ratio %
		Trees/ha	BA/ha	Vol/ha	Trees/ha	BA/ha	Vol/ha	Trees/ha	BA/ha	Vol/ha	
4	0	712			935			0			
3	5	450			550			0			
2	10	489			324			0			
1	15	264	4.67	24.88	1190	3.36	17.94	74	1.30	6.94	28
1	20	105	3.30	20.89	112	3.52	22.28	0	0.00	0.00	0
1	25	95	4.66	32.64	66	3.23	22.63	29	1.43	10.01	31
1	30	60	4.24	36.76	39	2.74	23.74	21	1.50	13.02	35
1	35	35	3.37	30.31	23	2.19	19.74	12	1.17	10.57	35
1	40	30	3.77	36.44	13	1.68	16.29	17	2.09	20.16	55
1	45	19	3.02	32.23	8	1.25	13.38	11	1.77	18.85	58
1	50	10	1.96	20.94	5	0.91	9.72	5	1.05	11.23	54
1	55	6	1.43	16.16	3	0.65	7.35	3	0.78	8.81	55
1	60	6	1.70	19.79	2	0.45	5.30	4	1.24	14.50	73
	TOTAL	2259	32.11	271.05	2269	20.00	158.36	177	12.33	114.08	

These specifications must be modified to specify a simple selection criterion to be used by fallers to select the trees to cut.

Example (suggested maximum 4 cutting rules):

- cut only trees greater than 12.5 cm dbh.
- dbh 12.5–17.5 cm: cut 1 of 4.
- dbh 22.5–37.5 cm: cut 1 of 3.
- dbh >37.5 cm: cut 1 of 2.

Modelling Growth and Yield

The cruise information can be used to run the forest stand model PROGNOSIS, which has been calibrated for interior dry-belt Douglas-fir. This computer model is used to calculate the volume remaining after "thinnings" (harvest or juvenile spacing) by diameter distribution and predict growth and yield over the specified cutting cycles.

The model PROGNOSIS has the potential to model the variable structure of interior Douglas-fir stands. Districts or Major Licensees may wish to use the model to aid in decision making. Districts should contact the Inventory Branch, Growth and Yield Section Manager for copies of the computer program and accompanying user manual.

APPENDIX 2. Completed Pre-harvest Obligation Definition (FS 708A)

Province of British Columbia — Ministry of Forests

MAJOR LICENCE SILVICULTURE INFORMATION SYSTEM

PRE-HARVEST OBLIGATION DEFINITION — **FORM 'A'**

** Note: Addition of extra column to record Layer
Form A is being amended. MLSIS has been amended to accomadate layers

A. TENURE

OBLIGATION: TIMBER MARK	OBLIGATION: BLOCK	LICENCE NO	LICENSEE	C.P.	CP/TO ENT	GROSS BLOCK AREA (ha)	NET FORESTED BLOCK AREA (ha)	PREPARED BY	TELEPHONE NO.	DATE: Y M D
Z1 2 3 4 5	1 0	A 1 2 3 4 5	Selection Systems	2 3	C 1	3 2 9 0	3 0 9 0	Joe Selection		8 8 0 4 1 5

PHSP 'A' — TU / LAYER

BIOGEOCLIMATIC: ZONE	BIOGEOCLIMATIC: SUBZONE
D F	x H 1

		NET AREA (ha)	SDO ASSOC	METHOD	TARGET STOCK	TARGET LEADER	PREFERRED SPECIES 1	PREFERRED SPECIES 2	ACCEPTABLE SPECIES 1	ACCEPTABLE SPECIES 2	ACCEPTABLE SPECIES 3	STOCK MIN.	SPACING MIN.	MAX. DENS.	REGEN YEARS	EARLY YEARS	LATE YEARS	TREE SIZE (cm): %	TREE SIZE (cm): cm	% SITE OCCUP.	PEST OCCURANCE: CODE	%	CODE	%	CODE	%
A	1	3090	0 1	N A T W R	6 0 0		F D I		D L I			3 0 0	0 9 0 0		3	3	1 5	1 2 5		0 4						
A	2	3090	0 1	N A T W R	8 0 0		F D I		P L I			4 0 0	2 9 0 0		3	3	1 5	1 2 5		0 4						
A	3	3090	0 1	N A T W R	1 0 0 0		F D I		D L I			6 0 0	2 9 0 0	1 0 0 0	3	3	1 5	1 2 5		0 4						
A	4	3090	0 1	N A T W R	1 2 0 0		F D I		P L I			7 0 0	2 9 0 0		3	3	1 5	1 2 5		0 4						

PHSP 'B' — TU / LAYER

BIOGEOCLIMATIC: ZONE	BIOGEOCLIMATIC: SUBZONE

NET AREA (ha)	SDO ASSOC	METHOD	TARGET STOCK	TARGET LEADER	PREFERRED SPECIES 1	PREFERRED SPECIES 2	ACCEPTABLE SPECIES 1	ACCEPTABLE SPECIES 2	ACCEPTABLE SPECIES 3	STOCK MIN.	SPACING MIN.	MAX. DENS.	REGEN YEARS	EARLY YEARS	LATE YEARS	TREE SIZE (cm): %	TREE SIZE (cm): cm	% SITE OCCUP.	PEST OCCURANCE: CODE	%	CODE	%	CODE	%

FOREST SERVICE USE

REG	DIST	AUTHORITY NO	REVIEWED BY	DATE APPROVED: Y M D
K	0 1	9 2 K 0 1 4 . 3 1	Fred Unevenaged	8 8 0 5 0 2

FS 708A EX. 2011

APPENDIX 3. Completed Silviculture Survey Plot Card (FS 658)

Province of British Columbia — Ministry of Forests

SILVICULTURE SURVEY PLOT

Page _____ of _____

REPORT NO. | SURVEY TYPE | OPENING NO. | STRATUM | POINT OF COMMENCEMENT | LINE

BEARING (AZIMUTH)	PLOT NO.	EA/ LAYER	TOTAL TREES	TOTAL CONIFERS	WELL-SPACED SPECIES	TOTAL W	TOTAL FG	LEADER HEIGHT (cm)	TOTAL HEIGHT (m)	AGE (years)	PLANTABLE	PREPARABLE	COMPETING VEGETATION SPECIES	% COVER	HEIGHT (cm)	COMMENTS
	1	1	1	1	1	1			20	80						Fdi 100 - 80 - 20
		2														
		3														
		4	3	3	2	2			1	7						Fdi 7 Pl 3 - 7 - 1.1
	2	1	1	1	1	1			25	100						
		2														
		3	3	3	2	2			6	20						
		4	3	3	1	1			1	7						
	3	1														
		2	4	4	3	3			10	50						
		3	3	3					5	10						
		4														
	4	1	1	1	1	1			15	60						
		2	2	2	1	1			8	40						
		3	3	3												
		4	6	6	3	3			0.9	6						

COMMENTS (prescriptions, snags, watercourses, wildlife, stand damage, etc.)

DATA ON THE LEADER HEIGHT, TOTAL HEIGHT AND AGE OF WELL SPACED TREES, MAIN COMPETING VEGETATION AND INVENTORY COMPONENT SHOULD BE RECORDED ON THE FIRST PLOT ESTABLISHED IN THE STRATUM AND EVERY FOURTH PLOT THEREAFTER. PEST TYPE, INCIDENCE AND SEVERITY SHOULD BE NOTED IN THE COMMENTS SECTION, WHEN OBSERVED.

FS 658 SIL 90/4

Province of British Columbia — Ministry of Forests

SILVICULTURE SURVEY PLOT

Page _____ of _____

REPORT NO. | SURVEY TYPE | OPENING NO. | STRATUM | POINT OF COMMENCEMENT | LINE

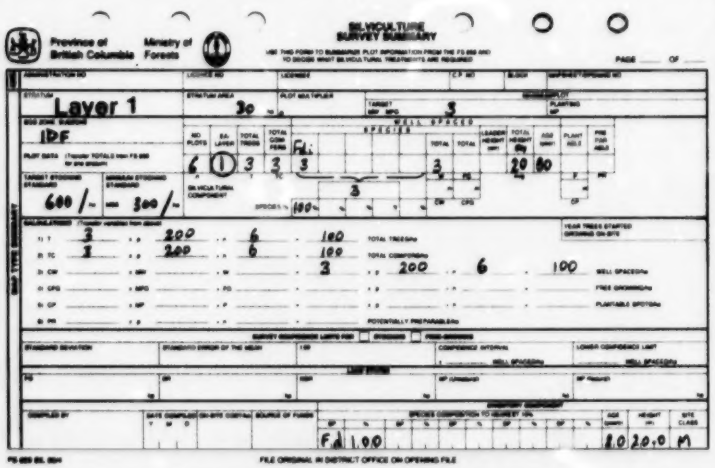
BEARING (AZIMUTH)	PLOT NO.	EA/ LAYER	TOTAL TREES	TOTAL CONIFERS	WELL-SPACED SPECIES	TOTAL W	TOTAL FG	LEADER HEIGHT (cm)	TOTAL HEIGHT (m)	AGE (years)	PLANTABLE	PREPARABLE	COMPETING VEGETATION SPECIES	% COVER	HEIGHT (cm)	COMMENTS
	5	1														
		2	3	3	2	2			12	60						Fdi 10 - 50 - 10.0
		3	3	3	2	2			6	20						Fdi 10 - 20 - 6.0
		4	3	3	1	1			1.1	8						Fdi 7 Pl 3 - 7 - 0.9
	6	1														
		2														
		3	3	3	2	2			7	22						
		4	3	3	2	2			1	7						
Summary		1	3	3	3	3			20	80						
		2	9	9	6	6			10	50						
		3	15	15	6	6			6	20						
		4	18	18	9	9			1	7						

COMMENTS (prescriptions, snags, watercourses, wildlife, stand damage, etc.)

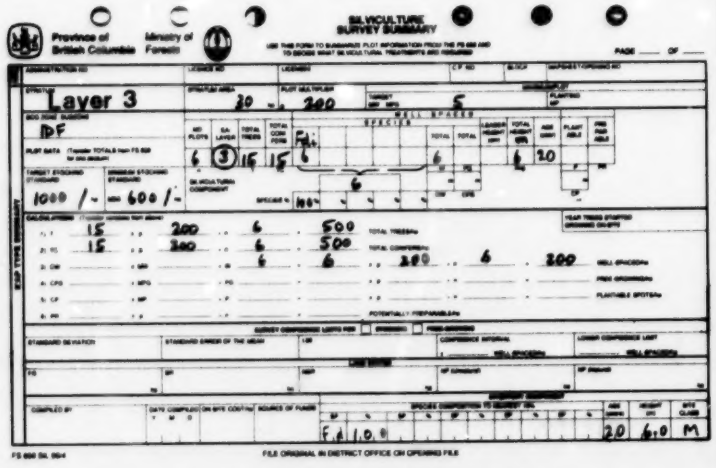
DATA ON THE LEADER HEIGHT, TOTAL HEIGHT AND AGE OF WELL SPACED TREES, MAIN COMPETING VEGETATION AND INVENTORY COMPONENT SHOULD BE RECORDED ON THE FIRST PLOT ESTABLISHED IN THE STRATUM AND EVERY FOURTH PLOT THEREAFTER. PEST TYPE, INCIDENCE AND SEVERITY SHOULD BE NOTED IN THE COMMENTS SECTION, WHEN OBSERVED.

FS 658 SIL 90/4

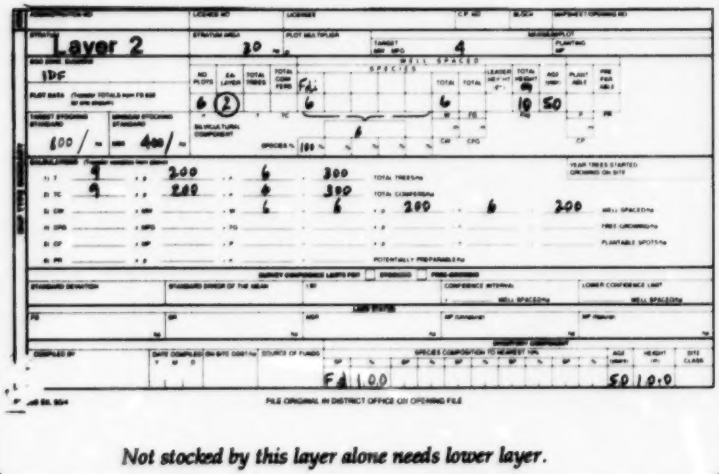
APPENDIX 4. Completed Silviculture Survey Summary (FS 659)


Province of British Columbia Ministry of Forests
SILVICULTURE SURVEY SUMMARY
Layer 1
IDF
600 / - 300 /-
Fd 1.0 0 10 20.0 M
FILE ORIGINAL IN DISTRICT OFFICE ON OPENING FILE

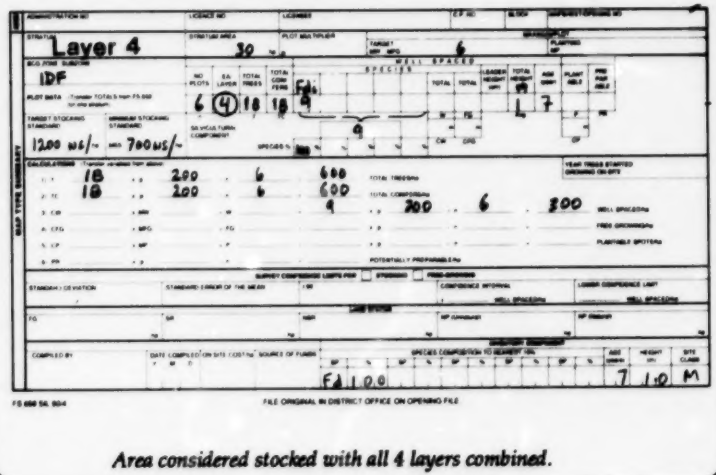
Not stocked by this layer alone needs lower layer.


Province of British Columbia Ministry of Forests
SILVICULTURE SURVEY SUMMARY
Layer 3
IDF
1000 / - 600 /-
Fd 1.0 0 20 6.0 M
FILE ORIGINAL IN DISTRICT OFFICE ON OPENING FILE

Not stocked by this layer alone needs lower layer.
The maximum density was not exceeded for this layer.


Layer 2
IDF
600 / - 400 /-
Fd 1.0 0 50 10.0
FILE ORIGINAL IN DISTRICT OFFICE ON OPENING FILE

Not stocked by this layer alone needs lower layer.


Layer 4
IDF
1200 ws/- 700 ws/-
Fd 1.0 0 7 1.0 M
FILE ORIGINAL IN DISTRICT OFFICE ON OPENING FILE

Area considered stocked with all 4 layers combined.

APPENDIX 5. Completed Forest Cover Definition Form (FS 708C)

Province of British Columbia — Ministry of Forests

MAJOR LICENCE SILVICULTURE INFORMATION SYSTEM

FOREST COVER DEFINITION — **FORM 'C'**

A.

TIMBER MARK	OBLIGATION BLOCK	PREPARED BY	TELEPHONE NO.	DATE Y	M	D
Z12345	19	Joe Selection		91	09	15

B.

STOCK TYPE	STOCK STATUS	SPECIES COMPOSITION										AGE YEARS	AGE SUFFIX	HEIGHT (0.1 M)	REF YEAR	SITE SERIES	DENSITY STEMS/ha	WELL SPACED	PEST INFESTATION						AREA (ha)
		SPECIES	%	SPECIES	%	SPECIES	%	SPECIES	%	SPECIES	%								CODE	%	CODE	%	CODE	%	
A1	SR	FDI	100									80		2090	91	M	1000	1000							3090
A2	SR	FDI	100									50		1090	91	M	3000	2000							3090
A3	SR	FDI	100									20		6090	91	M	5000	2000							3090
A4	SR	FDI	70	PLI	30							7		1090	91	M	6000	3000							3090

FOREST SERVICE USE

REVIEWED BY		DATE Y	M	D	REG.	DIST.
Fred	Unevenaged	91	09	05	K	01

FS 708C 94, 90/1

APPENDIX 6. Matrix of Information Needs and Timing of Assessment for Uneven-aged Management of Douglas-fir

Different types of information are needed at various times in the planning process. The following matrix provides a template of what type of information should be collected and when.

Information needs	Cruise	PHSP	Cutting permit	Post-harvest	Regeneration delay	Free growing	Comments
Layer 4	stems/ha cruise or PHSP	stems/ha cruise or PHSP			assess stems/ha	assess stems/ha	winter cruising may miss layer 4 stems making assessment at cruise or PHSP stage optional
Layer 3	stems/ha	assess quality by occular estimate		visually estimate	assess stems/ha	assess stems/ha	
Layer 2	stems/ha	assess quality by occular estimate			assess stems/ha	assess stems/ha	
Layer 1	stems/ha by 5 cm diameter class	assess quality by occular estimate			assess stems/ha	assess stems/ha	
Basal area		define minimum residual basal area		post-harvest assessment procedure			basal area will be used to determine if further, more specific post-harvest assessment is required
Damage due to harvest		assess effects on regeneration	state acceptable limits	assess for compliance to cutting permit guidelines			
Voids		state acceptable limits		assess for compliance with PHSP guidelines			
Cut specs			set out limits using appropriate clauses				assessment of compliance will follow the post-harvest assessment procedure

APPENDIX 7. Possible Research Areas

Uneven-aged guidelines for other subzones, e.g., ICH.

How is basal area growth distributed by diameter class after logging?

What is the B-level stocking (BA) by site index or site series for drybelt Douglas-fir sites?

What is the relationship between thermal cover, basal area and the time to re-occupy crown cover after harvesting?

Develop a more user-friendly computer program to calculate "q" values and Basal Area information similar to Nick Smith's UNEVEN program.

Growth and Yield

- "q" values for different ecosystems and structures.
- carrying capacity and growth rates.
- B-level stocking.
- cutting cycles.

Regeneration

- seed bed requirements.
- critical light levels for maximum growth by site type.
- seed production and periodicity.

Biodiversity

- biodiversity inventory (management indicator species).
- critical habitat structure.

Harvesting

- options on sensitive sites.
- assessment of blowdown probability.

APPENDIX 8. Glossary

Basal Area (BA): The cumulative cross-sectional area of stems at breast height per ha. When using prisms the BA is equal to the number of stems counted times the basal area factor of the prism.

"B-level" Stocking: Is the minimum stocking that residual trees fully occupy the site. This is often described as the residual stocking goal and is usually described in terms of BA/ha or in some cases Vol/ha.

Cutting Cycle: The amount of time between harvests. This is determined by estimating the stand growth from the minimum residual stocking level to the carrying capacity of the site.

Density: Total stems per hectare (see also stocking).

Faller Selection: A cutting method which the faller chooses the stems to cut based on pre-work instructions.

Inverse-J Curve: When the diameter distribution of total trees per ha is determined using the multiplier "q", and is plotted against diameter class, the resultant shape of the curve is that of an inverse-J (see Figure 1).

Maximum Diameter: To set up a diameter distribution goal based on "q," a maximum diameter tree to be left must be chosen. The maximum diameter size selected will be influenced by site quality, maximum annual increment, the importance of forest uses other than timber production, silvicultural objectives, and timber markets.

"q" Value: A multiplier that provides a stand diameter distribution with an increasing number of stems in smaller diameter classes. When the stand is divided into 5 cm diameter classes, a "q" or quotient of 1.2 to 2.0 has been used depending on existing structure. With higher "q" values more small trees will be retained on site. With a lower "q" value more large trees will be retained on site. One tree of a maximum diameter class is used as the starting point. For example, if the maximum tree size selected was 45 cm with a "q" of 2, there would be one tree in the 45-cm class, two trees in the 40-cm class, four trees in the 35-cm class, eight trees in the 30-cm class, and so on.

Residual Stocking: See "B-level" stocking.

Selection System: The removal of mature timber either as single scattered individuals or in small groups at relatively short intervals, repeated indefinitely, in which the continuous establishment of reproduction is encouraged and an uneven-aged stand is maintained.

Shelterwood: Removal of the old stand in a series of cuttings to promote the establishment of essentially even-aged reproduction under the partial shelter of the stand.

Silvicultural System: Is a planned program of treatment during the whole life of a stand. It includes reproduction cuttings but also includes tending or intermediate operations such as spacing and pruning.

Stand Structure: The distribution of stem sizes within the stand. Often manipulated to resemble an "inverse-J" shape when trees per ha are plotted against diameter class.

Stocking: A measure of the area occupied by trees. In British Columbia it is often measured in terms of well-spaced trees per ha (see also density).

APPENDIX 9. Suggested References

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